76255

Banded Impact melt Breccia

406.6 grams

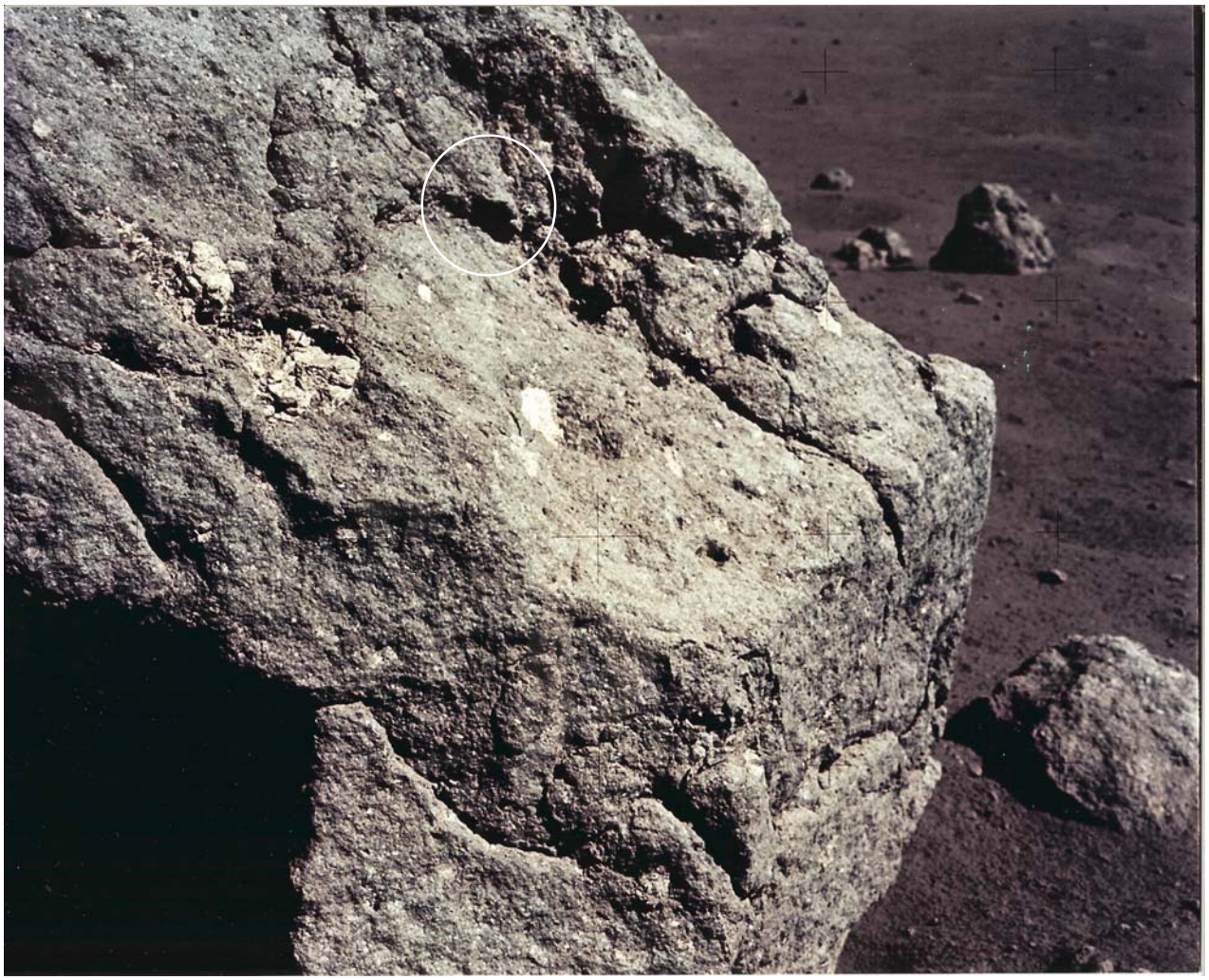


Figure 1: Close-up photo of block 1 of large boulder at station 6, Apollo 17, showing area where sample 76255 was collected. AS17-140-21443.

Figure 2: Sawn surface of 76255, 20. Cube is 1 inch. S75-22684.

Figure 3: Photo of sawn surface of slab ,26 cut through middle of 76255. Cube is 1 inch. S75-22687. Compare with sketch in figure 9.

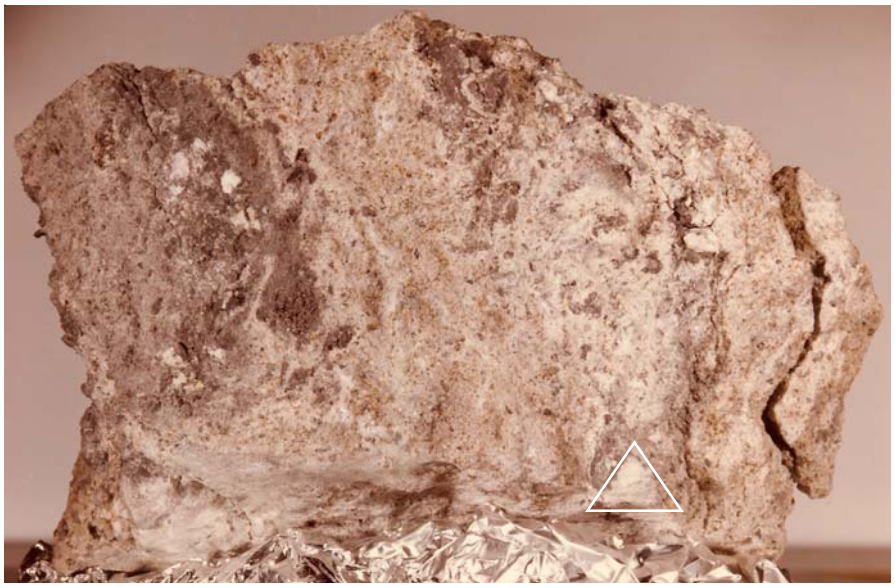


Figure 4: Photo of freshly broken inside surface of 76255. Sample is about 8 cm across. S72-56415. The bottom surface and the area marked by triangle are the "white clast".

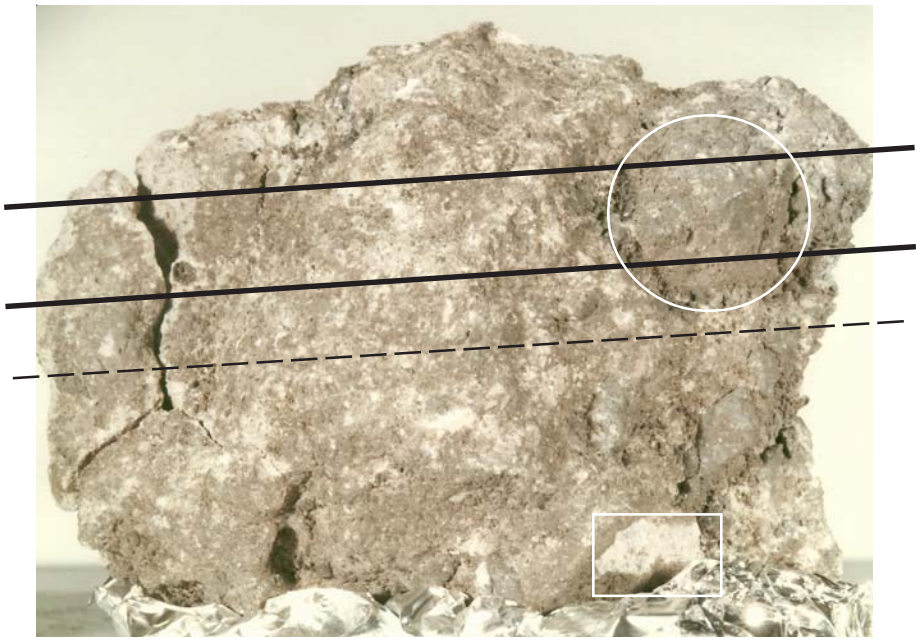


Figure 5: Photo of exterior surface, with patina, of 76255, showing the approximate location of first and second(?) slabs. S7256414. Note the fracture caused by the large zap pit. Note also the large dark clast in top right (circle) and the white clast at bottom (box).

Introduction

Sample 76255 was chipped by the astronauts from across the contact between unit C and a large clast (1 m) seen in the surface of block 1 of the large boulder at station 6 (figure 1). A large portion of the sample (~300 g) has been reported to be a "crushed norite" (poorly studied, to date).

Petrography

Warner et al. (1976) began the study of 76255 with what they called "absolute petrography". They described 76255 as a banded impact melt breccia (figure 4) with a large clast of crushed norite and several small white clasts. The outer surface (figure 5) contained a large zap pit, where a micrometeorite almost broke the rock.

Figure 6: Bottom side view of 76255 showing large "white clast" - which turned out to be very thin. S72-56417. Cube is 1 cm.

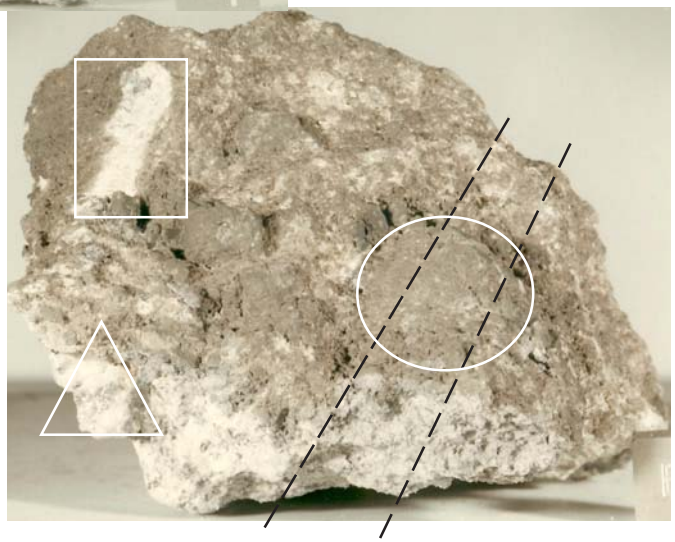


Figure 7: Photo of end of 76255 showing three clasts. S72-56412. About 7 cm across. The location of the dark clast and slab is indicated by circle. The triangle marks a piece of the large "white clast". The box is another clast (unstudied).

According to Warner et al., the matrix of 76255 is the finest-gained, most clast-laden, impact-melt breccia sampled from the large boulder. The texture of the matrix is subophitic with pyroxene and olivine oikocrysts, small spherical vesicles, and abundant mineral and lithic clasts. However, the matrix is variable with finer-grained, dark material intermixed with coarser-grained light material. The plagioclase inclusions in the breccia matrix are very calcic (An_{95}). The pyroxene composition is shown in figure 10.

Warner et al. (1976) reported on a number of clasts in 76255 (figures 12-15). Two small clasts of mare basalt were reported by Warner et al. in thin sections. The more significant clasts are mentioned below. James and Flohr (1983) recognized that some of the clasts were members of the mg-gabbronorite clan (figure 16). Ryder and Norman (1993) document the portions of 76255 that are pieces of the large crushed "norite" originally studied by Warner et al. (1976).

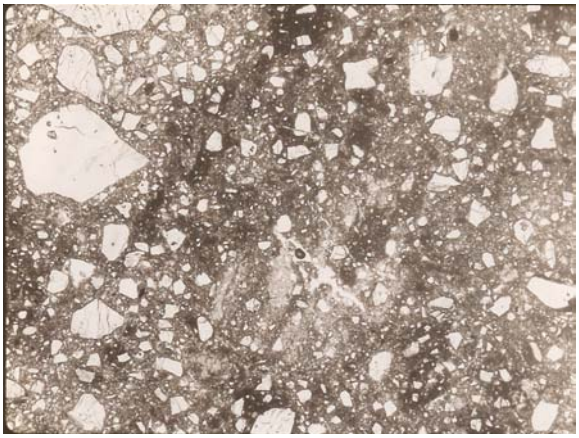


Figure 8: Thin section photomicrograph for 76255 (matrix). Scale about 5 mm.

Mineralogy

Olivine: Smith et al. (1980) reported trace elements in olivine in the matrix. Bersch et al. (1991) reported on the olivine in the troctolite clast.

Pyroxene: Figures 12-15 give the compositon of pyroxene in various lithologies of 76255. Takeda and Miyamoto (1977) studied inverted pyroxene

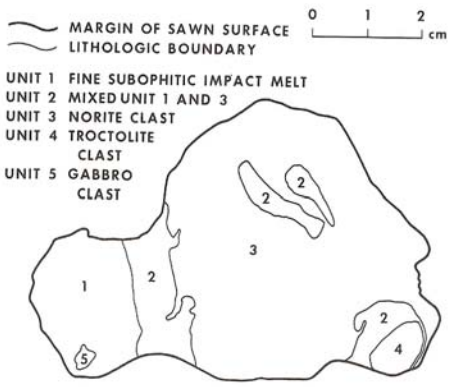


Figure 9: Sketch of sawn surface of 76255 slab (Warner et al. 1976), showing original designation of lithologies. Compare with figure 3.

Figure 10: Thin section photo of gabbro in 76255,72. Field of view about 2 mm.

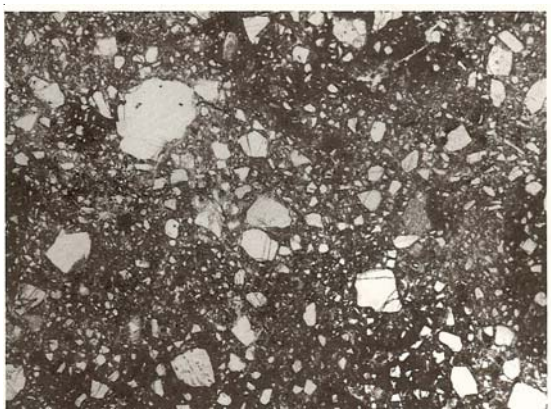


Figure 11: Thin section photo of "norite" in 76255,76. Field of view 5 mm.

Mineralogical mode for 76255

(from Warner et al. 1976)

	Matrix	Norite	Gabbro	Troctolite
Plagioclase	45%	51	39	77
Low-Ca Pyx.	12	38	4	
High-Ca Pyx.	2	11	57	
Olivine	32			23
Ilmenite	3			

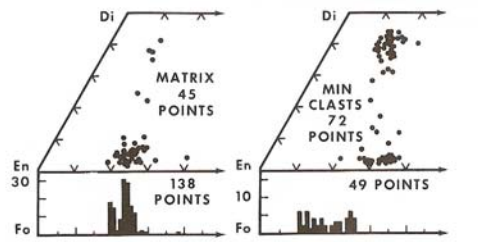


Figure 12: Composition of mafic minerals in matrix of 76255 (Warner et al. 1976).

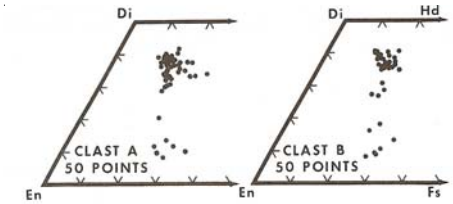


Figure 13: Composition of pyroxene in basalt clasts in matrix of 76255 (Warner et al. 1976).

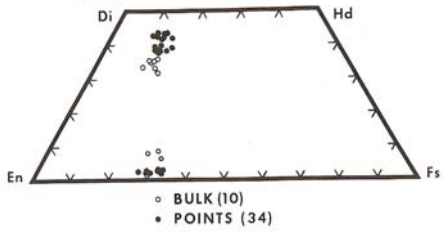


Figure 14: Composition of pyroxene in "gabbro" clast in 76255 (Warner et al. 1976).

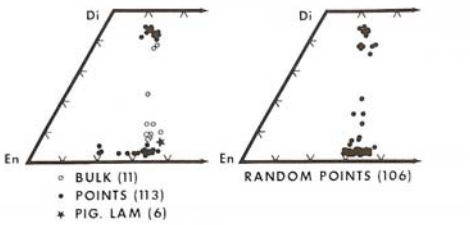


Figure 15: Composition of pyroxene in "norite" clast in 76255 (Warner et al. 1976).

in the norite clast. Bersch et al. (1991) also determined pyroxene composition in the norite.

Plagioclase: The plagioclase in the norite and gabbro clasts in 76255 is An_{87} (Warner et al. 1976). Steele et al. (1980) reported trace elements in plagioclase.

Significant Clasts

"White Clast": This "clast" turned out to be very thin (figure 6) and has apparently not been studied. Pieces of it may be found (?) among the fines from the return bag. The white material outlined by the triangles in figures 4, and 7 may be part of this clast.

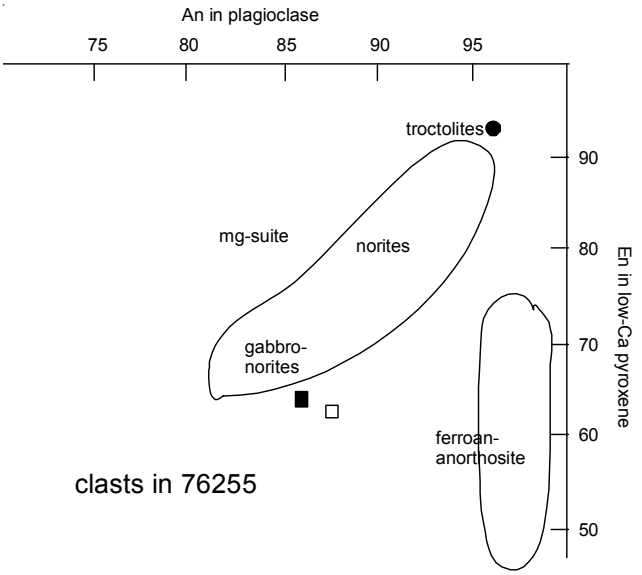


Figure 16: Composition of plagioclase and low-Ca pyroxene in clasts of 76255.

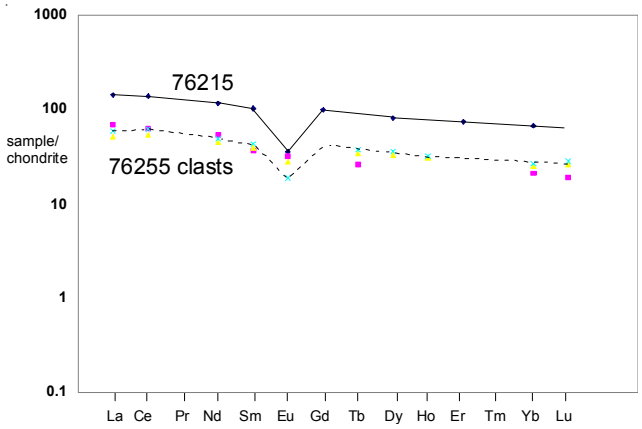


Figure 17: Normalized rare-earth-element diagram for clasts in 76255 compared with matrix of boulder (76215).

Rectangular white clast: Unstudied.
This clast is outlined with a box in figures 5, 6 and 7.

Gabbro: ,50 c2 Warren and Wasson (1979) - Warner unit 5?
A coarse-grained gabbro was found in 76255 (figure 10). According to Ryder and Norman (1979), this clast may not be from the location given in Warner et al. (1976), but was from a piece (,50) derived from the breakup of the rock.

Troctolite: ,29 c1 Warren and Wasson (1979) - Warner unit 4.
This clast was found within the large dark clast, circled in figures 5, and 7. See also figures 14 and 21. Warner et al. found the olivine was Fo_{89} and plagioclase was An_{95} (figure 16). Bersch et al. (1991) also analyzed the olivine in 76255,75.

Norite: Warren and Wasson (1979) – Warner unit 3. "300 grams?"
This "clast" is brecciated but has a monomict mineral assemblage with low siderophile content (figure 11). Pyroxene composition is given in figure 15 and Bersch et al. (1991) have carefully analysed the pyroxene in 76255,73. Anderson and Lindsley (1982) used the pyroxene data of Takeda and Miyamoto (1977) to calculate an equilibrium temperature of 800 deg C.

Dark aphanitic: A large clast of aphanitic material (~1 cm) is circled in figures 5 and 7. Cadogen and Turner (1976) dated this material as 4.02 ± 0.04 b.y. It contains the troctolite (c1) as a clast.

Chemistry

Mike Rhodes determined the major element content of various lithologies of 76255 (table 1). Clasts in sample 76255 have a lower trace element content than the boulder matrix (figure 17). Gros et al. (1976), Wolf et al. (1979) and Warren and Wasson (1986) reported trace element contents of the norite and troctolite clasts.

Several attempts have been made to measure the chemical composition of the large norite clast, but it was so permeated with breccia matrix, that Warner et al. (1976) claimed that clean separation were not possible. Note that the Th content of the bulk rock, determined by radiation counting, is relatively high.

Radiogenic age dating

Since 76255 was found as a clast in boulder 6, it is as old, or older than, the matrix samples of this boulder (76015, 76215, 76315), which are dated as 3.89 b.y. Cadogen and Turner (1976) dated aphanitic material from 76255 at 4.02 ± 0.04 b.y. (figure 18).

Cosmogenic isotopes and exposure ages

Rancitelli et al. (1974) determined the cosmic-ray-induced activity of ^{26}Al = 79 dpm/kg, ^{22}Na = 71 dpm/kg, ^{46}Sc = 3.9 dpm/kg, ^{54}Mn = 38 dpm/kg, ^{56}Co = 37 dpm/kg and ^{60}Co = 2.5 dpm/kg. Cadogen and Turner (1976) give an exposure age of 27 ± 3 m.y., while the age of emplacement of the boulder is generally thought to be about 20 m.y.

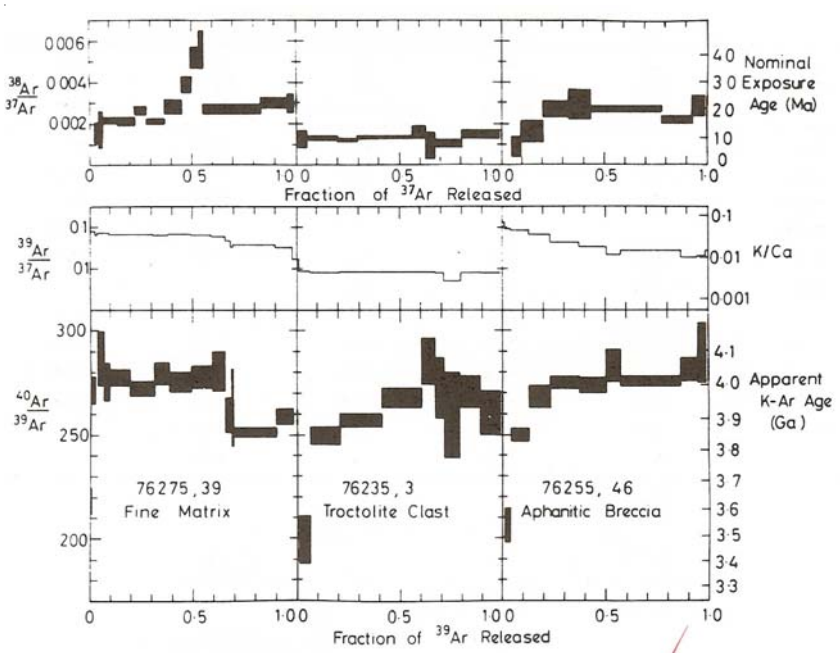


Figure 18: Ar/Ar release patterns for samples from station 6 boulder inc. 76255 (Turner and Cadogen 1976).

Figure 19: Sawn surface of thin butt end (,22) of 76255. S75-22686. Sample is 1.5 inches high. Saw marks are visible.

Other Studies

Gose et al. (1978) studied the magnetization of 76255 and Bogard (1974) determined the rare gas abundance.

Processing

There are two slabs of 76255 (,26 and ,100), and there are 23 thin sections. This sample, along with other samples of the large boulder at station 6, was the subject of a consortium study led by Bill Phinney. The photos of the boulder were "mapped" by Heiken et al. (1973). Sample 76255 is discussed in more detail in the catalog by Meyer (1994).

Summary of Age Data for 76255

	Ar/Ar
Cadogen and Turner 1976	4.02 ± 0.04 b.y.

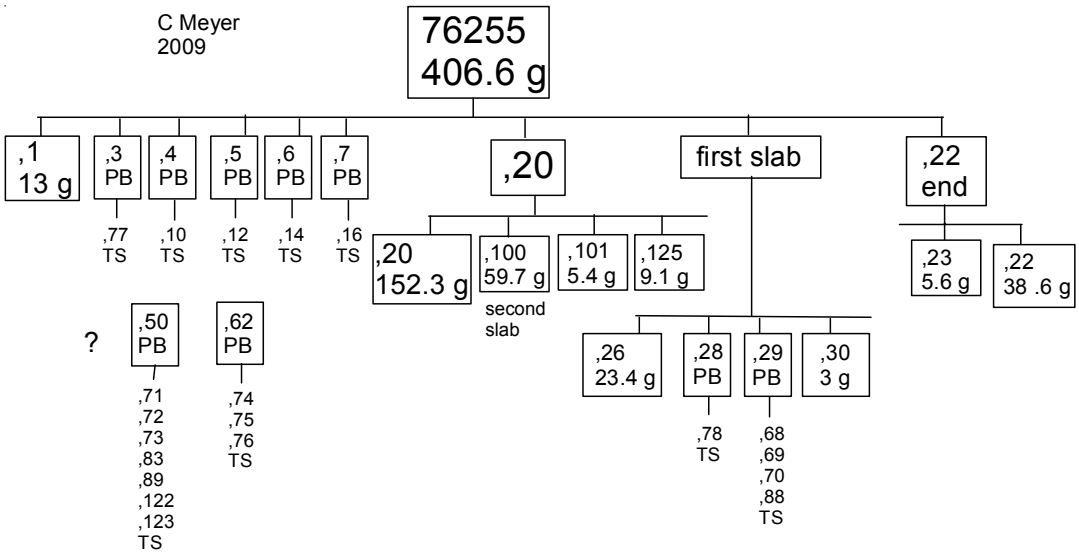
Caution: Old decay constant

Table 1. Chemical composition of 76255.

											Gros 76						
reference	Rancitelli74		Rhodes (unpublished, reported in Phinney 1981					Warren78		Wolf et al. 79				Warren86			
weight	393.2 g		,38 norite	matrix	,51	,55 clast	,58 clast			,58 clast		,56 N	,57 T		,95	,95	
SiO2 %			50.61	45.45	46.94	59.68	43.84	(d)	44.1	(b)					48.8		(b)
TiO2			0.75	1.6	1.66	1.37	0.25	(d)	2.7	(b)					0.83		(b)
Al2O3			15.37	18.91	19.04	15.89	25.15	(d)	26.1	(b)					16.8		(b)
FeO			9.8	7.4	7.21	9.36	4.23	(d)	4.25	(b)					8.1	7.7	(b)
MnO			0.19	0.11	0.13	0.17		(d)	0.047	(b)					0.13	0.12	(b)
MgO			11.14	13.88	11.86	11.23	11.02	(d)	10.2	(b)					12.1		(b)
CaO			11.05	11.78	12.47	11.17	14.2	(d)	15	(b)					11.6	11.6	(b)
Na2O			0.74	0.68	0.76	0.73	0.4	(d)	0.47	(b)					0.686	0.67	(b)
K2O	0.35	(a)	0.37	0.17	0.18	0.32	0.08	(d)							0.19	0.15	(b)
P2O5			0.03	0.24	0.22	0.01		(d)									
S %			0.09	0.03	0.03	0.03		(d)									
sum																	
Sc ppm									4.7	(b)					17.3	16.2	(b)
V																	
Cr									461	(b)					1310	1320	(b)
Co									19.4	(b)							
Ni									70	(b)	31	15	(c)		23	13	(b)
Cu																	
Zn									53	(b)	2	0.5	(c)				
Ga									4.81	(b)					4.2	4	(b)
Ge ppb									22	(b)	6.6	2.2	(c)		1.3		
As																	
Se											49	0.6	(c)				
Rb											12.8	0.19	(c)		4.2	3	(b)
Sr															156	158	(b)
Y																	
Zr									150	(b)					120	196	(b)
Nb																	
Mo																	
Ru																	
Rh																	
Pd ppb																	
Ag ppb											0.7	0.3	(c)				
Cd ppb									6.4	(b)	2	67	(c)				
In ppb									5	(b)	0.3	0.8	(c)				
Sn ppb																	
Sb ppb											0.11	2.4	(c)				
Te ppb											1.1	5.9	(c)				
Cs ppm											0.842	0.006	(c)		0.35	0.2	(b)
Ba									240	(b)					184	178	(b)
La									16.1	(b)					12.1	13.7	(b)
Ce									38	(b)					32	37	(b)
Pr																	
Nd									24	(b)					20.2	22.2	(b)
Sm									5.4	(b)					5.8	6.3	(b)
Eu									1.77	(b)					1.55	1.05	(b)
Gd																	
Tb									0.94	(b)					1.23	1.34	(b)
Dy															8	8.7	(b)
Ho															1.69	1.78	(b)
Er																	
Tm																	
Yb									3.4	(b)					4	4.3	(b)
Lu									0.46	(b)					0.63	0.68	(b)
Hf									3	(b)					3.8	4.3	(b)
Ta									0.27	(b)					0.41	0.42	(b)
W ppb																	
Re ppb											0.028	0.007	(c)		0.017		(b)
Os ppb											0.035	0.03	(c)		0.33		(b)
Ir ppb									0.63	(b)	0.042	0.019	(c)		0.077		(b)
Pt ppb																	
Au ppb									10.8	(b)	0.178	0.009	(c)		0.139	0.05	(b)
Th ppm	2.33	(a)							1.3	(b)					1.4	1.58	(b)
U ppm	0.58	(a)							0.38	(b)	0.445	0.019	(c)		0.38	0.38	(b)

technique: (a) radiation counting, (b) INAA, (c) RNAA, (d) XRF

Figure 20: Photo of second slab (,100) cut from 76255. Cube is 1 cm. S83-34593. The lack of obvious clasts in this cut must have been a disapointment.



Note: Be aware that there is a lot of confusion in the literature, as to which data belong to which clast – see Ryder and Norman (1979). The breccia guidebook by Phinney (1981) numbers the lithologies differently than in Warner et al. (1976). It will take a good detective (or new consortium) to unravel the details.

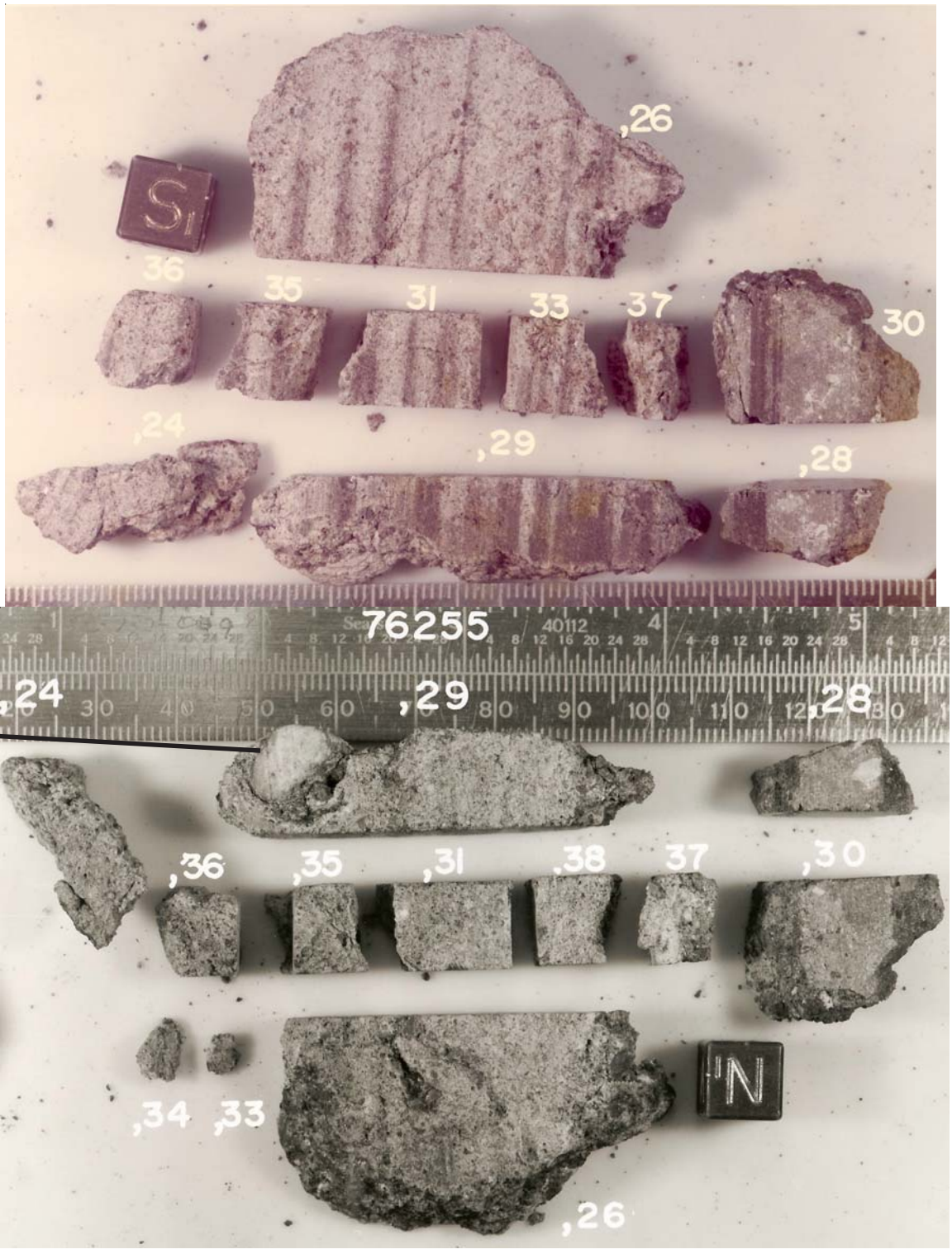


Figure 21: Subdivision of first slab (,26) cut from 76255. Cube and ruler are in cm. S75-23037. The nice white clast in ,29 was found to be a "troctolite".

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